



ARKANSAS

K-12 SCIENCE STANDARDS

EDUCATION FOR A NEW GENERATION

Accelerated Science Course Pathway

2016

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Notes:

1. Student Performance Expectations (PEs) may be taught in any sequence or grouping within a grade level. Several PEs are described as being “partially addressed in this course” because the same PE is revisited in a subsequent course during which that PE is fully addressed.
2. An asterisk (*) indicates an engineering connection to a practice, core idea, or crosscutting concept.
3. The Performance Expectation codes ending in **AR** indicate Arkansas-specific standards.
4. The Clarification Statements are examples and additional guidance for the instructor. **AR** indicates Arkansas-specific Clarification Statements.
5. The Assessment Boundaries delineate content that may be taught but not assessed in large-scale assessments. **AR** indicates Arkansas-specific Assessment Boundaries.
6. The section entitled “foundation boxes” is reproduced verbatim from *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*. Integrated and reprinted with permission from the National Academy of Sciences.
7. The examples given (e.g.,) are suggestions for the instructor.
8. Throughout this document, connections are provided to the nature of science as defined by *A Framework for K-12 Science Education* (NRC 2012).
9. Throughout this document, connections are provided to Engineering, Technology, and Applications of Science as defined by *A Framework for K-12 Science Education* (NRC 2012).
10. Each set of PEs lists connections to other disciplinary core ideas (DCIs) within the Arkansas K-12 Science Standards and to the Arkansas English Language Arts Standards, Arkansas Disciplinary Literacy Standards, and the Arkansas Mathematics Standards.

Accelerated Science Course Pathway Overview

Arkansas Accelerated Science Course Pathway allows districts and schools an option to maximize opportunities for high-performing students to meet the Arkansas K-12 Science Standards as well as be prepared to pursue advanced level science courses earlier in middle and high school and at a more rapid pace. This accelerated science course pathway is not intended for all students, but for students who have demonstrated advanced academic proficiency in the prerequisite courses and who intend to pursue a specific college and career pathway beyond high school.

Science is a quantitative discipline, so it is important for educators to ensure that students' science learning coheres well with their understanding of mathematics. To achieve this alignment, the Arkansas K-12 Science Committee made every effort to ensure that the mathematics standards do not outpace or misalign to the accelerated pathway courses. If this pathway is implemented, it is recommended that a unit of Algebra 1 be earned concurrently with a unit of Accelerated Physical Science, which requires a Grades 5-8 course approval for both the Algebra 1 and the Accelerated Physical Science course from the Arkansas Department of Education. Arkansas Accelerated Science Course Pathway details the following optional accelerated courses.

Accelerated 6th Grade Science	Course is an integration of 6th, 7th, and 8th Grade life science, Earth and space science, physical science, and engineering design standards.
Accelerated 7th Grade Science	Course is an integration of 6th, 7th, and 8th Grade life science, Earth and space science, physical science, and engineering design standards.
Accelerated Physical Science	Course is an integration of the balance of 8th Grade physical science standards not mapped in the Accelerated 6th and 7th Grade courses and the high school Physical Science course standards. *(5-8 course approval for physical science required)
Accelerated Biology	Course is an integration of the Biology course standards with additional life science standards and clarification statements written by the Arkansas K-12 Science Committee.
Accelerated Principles of Chemistry and Physics	Course is an integration of the Principles of Chemistry and Physics course standards with additional chemistry standards and clarification statements written by the Arkansas K-12 Science Committee.

* A course approval for Grades 5-8 is necessary for a high school course to be taught at the middle school level. Teachers must hold the appropriate 7-12 licensure. Contact the ADE Curriculum and Instruction unit for more details.

Accelerated Middle School Science Pathway

Key: Indicates from which course the PE was originally assigned.	
Physical Science	
8th Grade	
7th Grade	
6th Grade	
Engineering Design	

Accelerated Grade Six

Topic 1: Energy
PS-1-4
PS-1-6
PS-3-3
PS-3-4
PS-3-5
ETS 1-1
ETS 1-3
ETS 1-4
Topic 2: Earth Systems
ESS-2-1
ESS-2-2
ESS-2-4
ESS-3-1
ETS 1-1
Topic 3: Weather and Climate
ESS-2-5
ESS2-6
ESS-3-2
ESS-3-5
ETS 1-1
ETS 1-2
Topic 4: History of Earth
ESS-1-4
ESS-2-2
ESS-2-3
ESS-3-2
LS-4-1
Topic 5: Growth and Development
LS-1-4
LS-3-2
Topic 6: Natural Selection
LS-4-2
LS-4-3
LS-4-4
LS-4-6

Total Performance Expectations: 28 (7 Life, 12 Earth, 5 Physical, 4 ETS)

Accelerated Grade Seven

Topic 1: Structure and Function	
	LS-1-1
	LS-1-2
	LS-1-3
	LS-1-8
Topic 2: Chemical Reactions in Life Processes	
	LS-1-6
	LS-1-7
	PS-1-1
	PS-1-2
	PS-1-5
Topic 3: Growth and Development	
	LS-1-5
	LS-3-1
	LS-4-5
	ETS 1-3
Topic 4: Ecosystem Dynamics	
	ESS-3-4
	LS-2-1
	LS-2-3
	LS-2-4
	ETS 1-1
Topic 5: Human Impacts on Ecosystems	
	ESS-3-3
	LS-2-2
	LS-2-5
	PS-1-3
	ETS 1-1
	ETS 1-2
	ETS 1-4
Topic 6: Space Systems	
	ESS-1-1
	ESS-1-2
	ESS-1-3
	PS-2-4

Total Performance Expectations: 28 (14 Life, 5 Earth, 5 Physical, 4 ETS)

Accelerated Grade Eight (High School Physical Science)

Topic 1: Elements, Matter, and Interactions
HS-PS-1-1
HS-PS-1-2
HS-PS-1-3
HS-PS-1-4
HS-PS-1-7
HS-PS-3-4
Topic 2: Forces and Motion
MS-PS-2-1
MS-PS-2-2
MS-PS-3-1
MS-PS-3-2
HS-PS-2-1
HS-PS-2-2
HS-PS-2-3
HS-PS-2-4
Topic 3: Energy and Technology
MS-PS-2-3
MS-PS-2-5
HS-PS-3-1
HS-PS-3-2
HS-PS-3-3
HS-PS-2-5
HS-PS-2-6
HS-PS-3-5
HS-ETS-1-1
HS-ETS-1-3
Topic 4: Waves and Their Applications
MS-PS-4-1
MS-PS-4-2
MS-PS-4-3
HS-PS-4-1
HS-PS-4-2
HS-ETS-1-2
Topic 5: Human Impacts
HS-LS-2-7
HS-LS-4-5
HS-ESS-2-1
HS-ESS-3-1
HS-ESS-3-2
HS-ETS-1-1
HS-ETS-1-2
HS-ETS-1-3

Accelerated High School Science Course Pathway

Accelerated Biology

Learning Progression Chart

Topic 1: Cycling of Matter and Energy	Topic 2: Structure and Function	Topic 3: Biodiversity and Population Dynamics	Topic 4: Genetic Variations in Organisms	Topic 5: Evolution by Natural Selection	Topic 6: Life and Earth's Systems	Topic 7: Human Impacts on Earth's Systems
B-LS1-5	B-LS1-1	B-LS2-1	B-LS1-4	B-LS4-1	B-ESS2-2	B-ESS3-1
B-LS1-7	B-LS1-2	B-LS2-2	B-LS3-1	B-LS4-2	B-ESS2-4	B-ESS3-2
B-LS2-3	B-LS1-3	B-LS2-6	B-LS3-2	B-LS4-3	B-ESS2-5	B-ESS3-3
B-LS2-4	B-LS1-3 ^{ARa}	B-LS2-7	B-LS3-3	B-LS4-4	B-ESS3-5	B-ESS3-4
B-LS2-5	B-LS1-3 ^{ARb}	B-LS2-8	B-4-ETS1-2	B-LS4-5	B-6-ETS1-2	B-ESS3-6
B-ESS2-6	B-LS1-6	B-LS4-6		B-LS4-7 ^{AR}	B-6-ETS1-3	B-7-ETS1-1
	B-LS1-8 ^{AR}	B-3-ETS1-3		B-LS4-8 ^{AR}		B-7-ETS1-2
		B-3-ETS1-4		B-ESS2-7		B-7-ETS1-4

Arkansas Performance Expectation (^{AR})

Accelerated biology is a course composed of the Biology course standards with additional life science standards and clarification statements written by the Arkansas K-12 Science Committee.

The performance expectations in **Topic 1: Cycling of Matter** help students answer the question:

- How do matter and energy move through an ecosystem?

Students construct explanations, develop models, and use mathematical representations to demonstrate how the cycling of carbon-based molecules through photosynthesis and cellular respiration enables the flow of energy among organisms and within ecosystems. Students use quantitative models specifically to illustrate the role of photosynthesis and cellular respiration as two processes by which carbon is cycled among the biosphere, atmosphere, hydrosphere, and geosphere. Students use evidence to construct and revise an explanation of the role of aerobic and anaerobic respiration in different environments.

The performance expectations in **Topic 2: Structure and Function** help students formulate an answer to the question:

- How do the structures of organisms enable living organisms to function?

Students model how a few elements combine to form complex biological molecules by dehydration synthesis. Students investigate explanations for the structure and function of cells as the basic units of life, the hierarchical systems of organisms, and the role of specialized cells for maintenance and growth. Students demonstrate understanding of how systems of cells function together to support the life processes by reading critically, using models, and conducting investigations. Students use a group of specific body systems to explain the interaction of

systems in maintaining homeostasis. Students model a negative feedback loop to demonstrate understanding of homeostasis. Students explore various mechanisms of cell signaling and explain how a problem with cell signaling can lead to disorder. Students perform various investigations with real and simulated cell membranes to demonstrate the structure of a selectively permeable membrane and transport mechanisms.

The performance expectations in **Topic 3: Biodiversity and Population Dynamics** help students answer the question:

- How do biotic and abiotic factors affect biodiversity?

Students investigate the role of biodiversity in ecosystems and the role of animal behavior on survival of individuals and species. Students analyze organisms' interactions with each other and their physical environment including symbiotic relationships, how organisms change the environment, and how these changes affect both organisms and the environment. Students use evidence to explain those interactions and changes. Students explore solutions for major global problems, evaluate possible solutions for reducing the impact of human activities on biodiversity, and use computer simulations to model and test those solutions, considering a wide range of criteria including cost-benefit analysis.

The performance expectations in **Topic 4: Genetic Variations in Organisms** help students in formulating answers to the questions:

- How are the characteristics of one generation related to previous and future generations?
- How does genetic variation contribute to biodiversity?

Students explain the relationship of DNA and chromosomes to cellular division, protein synthesis, and mutations. Students investigate mitosis within the cell cycle including the control mechanisms and the events occurring within interphase including DNA replication. Students analyze the mechanisms of inheritance and gene expression, as well as environmental and genetic causes of gene mutations. Students formulate questions and construct arguments about ethical issues related to the genetic modification of organisms. Students develop conceptual models for the role of DNA in the unity of life on earth and use statistical models to explain the importance of variation within population for the survival and evolution of species.

The performance expectations in **Topic 5: Evolution by Natural Selection** help students answer the questions:

- How can very different organisms also have so many similarities?
- What causes species to change over time?

Students investigate the claim that eukaryotic cells evolved from prokaryotic cells by making a comparison of the structure of prokaryotic and eukaryotic cells with an emphasis on compartmentalization and complexity as outlined in the theory of endosymbiosis. Students investigate patterns to find relationships between environmental conditions and natural selection, highlighting factors that drive the evolution or extinction of species over time. Students utilize statistics and probability to investigate the distribution of genes and traits in a population over time, demonstrating how natural selection leads to the adaptation of populations. Students analyze scientific evidence ranging from the fossil record to genetic relationships to evaluate how multiple lines of evidence support the scientific theories of natural selection and evolution. Students use a cladogram or phylogenetic tree to model proposed evolutionary relationships.

The performance expectations in **Topic 6: Life and Earth's Systems** help students answer the question:

- How does life influence Earth's systems?
- How do Earth's systems influence life?

Students investigate the interrelationships between biotic and abiotic factors that contribute to changes in Earth's dynamic systems. Students examine how Earth's systems may appear stable, change slowly over long periods of time, or change abruptly, with significant consequences for living organisms. Students develop models and analyze data to explain and forecast changes to Earth's various climates. Students examine how climate change can occur when certain parts of Earth's systems are altered and predict how living organisms may affect and be affected. Students study the relationship of blue-green algae and oxygen concentration in the atmosphere; then, investigate how the rate of fresh water intrusion from melting polar ice affects the growth of the blue-green algae. Students model the structure of the water molecule and explain how the structure and properties of water are essential to the moderation of climate. Students use both qualitative and quantitative data to support their analysis and conclusion.

The performance expectations in **Topic 7: Human Impacts on Earth's Systems** help students formulate answers to the questions:

- How have Earth's systems affected human populations and human activities?
- How do human activities impact Earth's systems?

Students examine the complex interdependence between humans and their environment by simulating specific relationships between natural resources, natural hazards, climate, biodiversity, and the sustainability of human populations. Students research sustainability practices that promote the conservation of natural resources. Students analyze geoscience models to highlight the interactions between Earth's various systems, forecast future rates of global or regional climate change, and predict the resulting impacts on the environment. Students utilize science and engineering practices to evaluate and refine solutions that reduce human impacts on natural systems, managing natural resources, protecting biodiversity, and maintaining healthy ecosystems. Students analyze current regional or global issues, such as the spread of viruses and their impact on health, the economy and society. Students use both qualitative and quantitative data to support their analysis and conclusion.

Additionally, it should be noted that the accelerated biology standards are not intended to be used as curriculum. Instead, the standards are the minimum that students should know and be able to do. Therefore, teachers should continue to differentiate for the needs of their students by adding depth and additional rigor.

Students in accelerated biology also continue their ability to develop possible solutions for major global problems with engineering design challenges. At the high school level, students are expected to engage with major global issues at the interface of science, technology, society and the environment, and to bring to bear the kinds of analytical and strategic thinking that prior training and increased maturity make possible. As in prior levels, these capabilities can be thought of in three stages—defining the problem, developing possible solutions, and improving designs:

- **Defining the problem** at the high school level requires both qualitative and quantitative analysis. For example, the need to provide food and fresh water for future generations comes into sharp focus when considering the speed at which world population is growing, and conditions in countries that have experienced famine. While high school students are not expected to solve these challenges, they are expected to begin thinking about them as problems that can be addressed, at least in part, through engineering.
- **Developing possible solutions** for major global problems begins by breaking them down into smaller problems that can be tackled with engineering methods. To evaluate potential solutions students are expected to not only consider a wide range of criteria, but to also recognize that criteria need to be prioritized. For example, public safety or environmental protection may be more important than cost or even functionality. Decisions on priorities can then guide tradeoff choices.
- **Improving designs** at the high school level may involve sophisticated methods, such as using computer simulations to model proposed solutions. Students are expected to use such methods to take into account a range of criteria and constraints, to try and anticipate possible societal and environmental impacts, and to test the validity of their simulations by comparison to the real world.

Accelerated Principles of Chemistry and Physics

Principles of Chemistry and Physics Learning Progression Chart

Topic 1: Matter and Chemical Reactions	Topic 2: Nuclear Reactions	Topic 3: Energy Flow	Topic 4: Waves	Topic 5: Forces	Topic 6: Systems
PCP-PS1-1	PCP-PS1-8	PCP-PS1-4	PCP-PS4-1	PCP-PS2-1	PCP-ESS2-5
PCP-PS1-2	PCP-ESS1-1	PCP-PS1-5	PCP-PS4-3	PCP-PS2-2	PCP-ESS3-3
PCP-PS1-3	PCP-ESS1-3	PCP-PS3-1	PCP-PS4-4	PCP-PS2-4	PCP-PS1-10 ^{AR}
PCP-PS1-6	PCP-ESS1-6	PCP-ESS1-2	PCP-PS4-5	PCP-PS3-5	PCP-6-ETS1-3
PCP-PS1-7	PCP-2-ETS1-1	PCP-ESS2-3	PCP-4-ETS1-4	PCP-ESS1-4	PCP-6-ETS1-4
PCP-PS1-9 ^{AR}	PCP-2-ETS1-2	PCP-ESS3-4		PCP-ESS1-5	
	PCP-2-ETS1-3	PCP-3-ETS1-1		PCP-5-ETS1-2	
PCP-ETS1-2	PCP-2-ETS1-4				

Arkansas Performance Expectation (^{AR})

Accelerated principles of chemistry and physics is a course composed of the principles of chemistry and physics course standards with additional chemistry standards and clarification statements written by the Arkansas K-12 Science Committee.

PCP Differentiation:

Topic 1: Matter and Chemical Reactions

One PE was created: PCP-PS1-9^{AR} Clarification statements were revised for PCP-PS 1-1, PCP-PS1-2, PCP-PS1-3, and PCP-PS1-7 to emphasize concepts related to the topic of Matter and Chemical Reactions. Emphasis is on stoichiometry with limiting reactants, net ionic equations, chemical analysis in the context of percent composition, empirical and molecular formulas, chemical nomenclature, and constructing particulate diagrams illustrating intermolecular forces.

Topic 2: Nuclear Reactions

Topic 3: Energy Flow

Topic 4: Waves

Topic 5: Forces

Topic 6: Systems

Topic 7: Behavior of Gases One PE was created: PCP-PS1-10^{AR}

Accelerated Science Grade 6

Topic 1: Energy

Students who demonstrate understanding can:

- 6-PS3-3** Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.* [AR Clarification Statement: Examples of devices could include an insulated box, a solar cooker, and a polystyrene foam cup.] [Assessment Boundary: Assessment does not include calculating the total amount of thermal energy transferred.]
- 6-PS3-4** Plan an investigation to determine the relationships among the energy transferred, the type of matter, The mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample. [Clarification Statement: Examples of experiments could include comparing final water temperatures after different masses of ice have melted in the same volume of water with the same initial temperature, the temperature change of samples of different materials with the same mass as they cool or heat in the environment, or the same material with different masses when a specific amount of energy is added.] [Assessment Boundary: Assessment does not include calculating the total amount of thermal energy transferred.]
- 6-PS3-5** Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object. [AR Clarification Statement: Examples of empirical evidence used in arguments could include a diagram, flowchart, or other representation of the energy before and after the transfer in the form of temperature changes or motion of an object.] [Assessment Boundary: Assessment does not include calculations of energy.]
- 7-PS1-4** Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed. [Clarification Statement: Emphasis is on qualitative molecular-level models of solids, liquids, and gases to show that adding or removing thermal energy increases or decreases kinetic energy of the particles until a change of state occurs. Examples of models could include drawings or diagrams. Examples of particles could include molecules or inert atoms. Examples of pure substances could include water, carbon dioxide, and helium.]
- 7-PS1-6** Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes.* [AR Clarification Statement: Emphasis is on the design, controlling the transfer of energy to the environment, and modification of a device using factors such as type and concentration of a substance. Examples of designs could involve chemical processes such as dissolving ammonium chloride or calcium chloride or chemical reactions such as burning.] [Assessment Boundary: Assessment is limited to the criteria of amount, time, and temperature of substance in testing the device.]
- 6-ETS1-1** Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions. [AR Clarification Statement: Examples could include designing an insulated coffee mug or lunch box or designing an energy efficient home.]
- 6-ETS1-3** Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success. [AR Clarification Statement: Examples could include determining best materials to use for a building's roof or windows.]
- 6-ETS1-4** Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved. [AR Clarification Statement: Examples could be using graphs or models to support material choices for a design project.]

The performance expectations above were rearranged using the Arkansas K-12 Science Standards for Grades 6-8.

Topic 2: Earth Systems

Students who demonstrate understanding can:

- 6-ESS-2-4** **Develop a model to describe the cycling of water through Earth's systems driven by energy from the Sun and the force of gravity.** [Clarification Statement: Emphasis is on the ways water changes its state as it moves through the multiple pathways of the hydrologic cycle. Examples of models can be conceptual or physical.] [Assessment Boundary: A quantitative understanding of the latent heats of vaporization and fusion is not assessed.]
- 7-ESS-2-1** **Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process.** [AR Clarification Statement: Emphasis is on the processes of melting, crystallization, weathering, deformation, and sedimentation, which act together to form minerals and rocks through the cycling of Earth's materials. Arkansas specific examples of geologic materials include Karst, bauxite, and diamonds.] [Assessment Boundary: Assessment does not include the identification and naming of minerals.]
- 7-ESS-2-2** **Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales.** [AR Clarification Statement: This PE is partially addressed in Topic 4. Emphasis is on how processes change Earth's surface at time and spatial scales that can be large (such as slow plate motions or the uplift of large mountain ranges) or small (such as rapid landslides or microscopic geochemical reactions), and how many geoscience processes (such as earthquakes, volcanoes, and meteor impacts) usually behave gradually but are punctuated by catastrophic events. Examples of geoscience processes include surface weathering and deposition by the movements of water, ice, and wind. Emphasis is on geoscience processes that shape local geographic features.]
- 7-ESS-3-1** **Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geoscience processes.** [Clarification Statement: Emphasis is on how these resources are limited and typically non-renewable, and how their distributions are significantly changing as a result of removal by humans. Examples of uneven distributions of resources as a result of past processes include but are not limited to petroleum (locations of the burial of organic marine sediments and subsequent geologic traps), metal ores (locations of past volcanic and hydrothermal activity associated with subduction zones), and soil (locations of active weathering and/or deposition of rock).]

The performance expectations above were rearranged using the Arkansas K-12 Science Standards for Grades 6-7.

Topic 3: Weather and Climate

Students who demonstrate understanding can:

- 6-ESS2-5 Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions.** [Clarification Statement: Emphasis is on how air masses flow from regions of high pressure to low pressure, causing weather (defined by temperature, pressure, humidity, precipitation, and wind) at a fixed location to change over time, and how sudden changes in weather can result when different air masses collide. Emphasis is on how weather can be predicted within probabilistic ranges. Examples of data can be provided to students (such as weather maps, diagrams, or visualizations) or obtained through laboratory experiments (such as with condensation).] [Assessment Boundary: Assessment does not include recalling the names of cloud types or weather symbols used on weather maps or the reported diagrams from weather stations.]
- 6-ESS2-6 Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates.** [Clarification Statement: Emphasis is on how patterns vary by latitude, altitude, and geographic land distribution. Emphasis of atmospheric circulation is on the sunlight-driven latitudinal banding, the Coriolis effect, and resulting prevailing winds; emphasis of ocean circulation is on the transfer of heat by the global ocean convection cycle, which is constrained by the Coriolis effect and the outlines of continents. Examples of models could be diagrams, maps and globes, or digital representations.] [Assessment Boundary: Assessment does not include the dynamics of the Coriolis effect.]
- 6-ESS3-5 Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.** [Clarification Statement: Examples of factors include human activities (such as fossil fuel combustion, cement production, or agricultural activity) and natural processes (such as changes in incoming solar radiation or volcanic activity). Examples of evidence could include tables, graphs, and maps of global and regional temperatures, atmospheric levels of gases such as carbon dioxide or methane, and the rates of human activities. Emphasis is on the major role that human activities play in causing the rise in global temperatures.]
- 7-ESS3-2 Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.** [AR Clarification Statement: This topic is partially addressed in Topic 4. Emphasis is on how some natural hazards, such as volcanic eruptions and severe weather, are preceded by phenomena that allow for reliable predictions, but others, such as earthquakes, occur suddenly and with no notice, and thus are not yet predictable. Examples of natural hazards can be taken from interior processes (such as earthquakes and volcanic eruptions), surface processes (such as mass wasting and tsunamis), or severe weather events (such as hurricanes, tornadoes, and floods). Examples of data can include the locations, magnitudes, and frequencies of the natural hazards. Examples of technologies can be global (such as satellite systems to monitor hurricanes or forest fires) or local (such as building basements in tornado-prone regions or reservoirs to mitigate droughts).]
- 6-ETS1-1 Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.** [AR Clarification Statement: Examples could include designing technologies (such as levees, dams, storm shelters) and determining their ability to mitigate the effects of future weather events.]
- 6-ETS1-2 Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.** [AR Clarification Statement: Examples could include evaluating human technologies (such as levees, dams, storm shelters) and determining their ability to mitigate the effects of future weather events.]

The performance expectations above were rearranged using the Arkansas K-12 Science Standards for Grades 6-7.

Topic 4: History of Earth

Students who demonstrate understanding can:

- 7-ESS2-2 Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales.** [AR Clarification Statement: This PE is partially addressed in Topic 2. Emphasis is on how processes change Earth's surface at time and spatial scales that can be large (such as slow plate motions or the uplift of large mountain ranges) or small (such as rapid landslides or microscopic geochemical reactions), and how many geoscience processes (such as earthquakes, volcanoes, and meteor impacts) usually behave gradually but are punctuated by catastrophic events. Examples of geoscience processes include surface weathering and deposition by the movements of water, ice, and wind. Emphasis is on geoscience processes that shape local geographic features, where appropriate.]
- 7-ESS2-3 Analyze and interpret data on the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence of the past plate motions.** [Clarification Statement: Examples of data include similarities of rock and fossil types on different continents, the shapes of the continents (including continental shelves), and the locations of ocean structures (such as ridges, fracture zones, or trenches).] [Assessment Boundary: Paleomagnetic anomalies in oceanic and continental crust are not assessed.]
- 7-ESS3-2 Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.** [AR Clarification Statement: This PE is partially addressed in Topic 3. Emphasis is on how some natural hazards, such as volcanic eruptions and severe weather, are preceded by phenomena that allow for reliable predictions, but others, such as earthquakes, occur suddenly and with no notice, and thus are not yet predictable. Examples of natural hazards can be taken from interior processes (such as earthquakes and volcanic eruptions), surface processes (such as mass wasting and tsunamis), or severe weather events (such as hurricanes, tornadoes, and floods). Examples of data can include the locations, magnitudes, and frequencies of the natural hazards. Examples of technologies can be global (such as satellite systems to monitor hurricanes or forest fires) or local (such as building basements in tornado-prone regions or reservoirs to mitigate droughts).]
- 8-LS4-1 Analyze and interpret data for patterns in the fossil record that document the existence, diversity, extinction, and change of life forms throughout the history of life on Earth under the assumption that natural laws operate today as in the past.** [Clarification Statement: Emphasis is on finding patterns of change in the level of complexity of anatomical structures in organisms or the chronological order of fossil appearance in the rock layers.] [Assessment Boundary: Assessment does not include the names of individual species or geological eras in the fossil record.]
- 8-ESS1-4 Construct a scientific explanation based on evidence from rock strata for how the geologic time scale is used to organize Earth's 4.6-billion-year-old history.** [Clarification Statement: Emphasis is on how analyses of rock formations and the fossils they contain are used to establish relative ages of major events in Earth's history. Examples of Earth's major events could range from being very recent (such as the last Ice Age or the earliest fossil of Homo sapiens) to very old (such as the formation of Earth or the earliest evidence of life). Examples can include the formation of mountain chains or ocean basins, the evolution or extinction of particular living organisms, or significant volcanic eruptions.] [Assessment Boundary: Assessment does not include recalling the names of specific periods or epochs and events within them.]

The performance expectations above were rearranged using the Arkansas K-12 Science Standards for Grades 7-8.

Topic 5: Growth Development

Students who demonstrate understanding can:

- 6-LS1-4 Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively.** [Clarification Statement: Examples of behaviors that affect the probability of animal reproduction could include nest building to protect young from cold, herding of animals to protect young from predators, and vocalization of animals and colorful plumage to attract mates for breeding. Examples of animal behaviors that affect the probability of plant reproduction could include transferring pollen or seeds, and creating conditions for seed germination and growth. Examples of plant structures could include bright flowers attracting butterflies that transfer pollen, flower nectar and odors that attract insects that transfer pollen, and hard shells on nuts that squirrels bury.]
- 6-LS3-2 Develop and use a model to describe why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation.** [Clarification Statement: Emphasis is on using models such as Punnett squares, diagrams, and simulations to describe the cause and effect relationship of gene transmission from parent(s) to offspring and resulting genetic variation.]

The performance expectations above were rearranged using the Arkansas K-12 Science Standards for Grade 6.

Topic 6: Natural Selection

Students who demonstrate understanding can:

- 8-LS4-2 Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer evolutionary relationships.** [Clarification Statement: Emphasis is on explanations of the evolutionary relationships among organisms in terms of similarities or differences of the gross appearance of anatomical structures.]
- 8-LS4-3 Analyze displays of pictorial data to compare patterns of similarities in the embryological development across multiple species to identify relationships not evident in the fully formed anatomy.** [Clarification Statement: Emphasis is on inferring general patterns of relatedness among embryos of different organisms by comparing the macroscopic appearance of diagrams or pictures.] [Assessment Boundary: Assessment of comparisons is limited to gross appearance of anatomical structures in embryological development.]
- 8-LS4-4 Construct an explanation based on evidence that describes how genetic variations of traits in a population increase some individuals' probability of surviving and reproducing in a specific environment.**
- 8-LS4-6 Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time.** [Clarification Statement: Emphasis is on using mathematical models, probability statements, or proportional reasoning to support explanations of

trends in changes to populations over time.] [Assessment Boundary: Assessment does not include Hardy Weinberg calculations.]

The performance expectations above were rearranged using the Arkansas K-12 Science Standards for Grade 8.

Accelerated Science Grade 7

Topic 1: Structure and Function

Students who demonstrate understanding can:

- 6-LS1-1 Conduct an investigation to provide evidence that living things are made of cells; either one cell or many different numbers and types of cells.** [Clarification Statement: Emphasis is on gathering evidence that living things are made of cells, distinguishing between living and non-living things, and understanding that living things may be made of one cell or many and varied cells.]
- 6-LS1-2 Develop and use a model to describe the function of a cell as a whole and ways parts of cells contribute to the function.** [Clarification Statement: Emphasis is on the cell functioning as a whole system and the primary role of identified parts of the cell, specifically the nucleus, chloroplasts, mitochondria, cell membrane, and cell wall.] [Assessment Boundary: Assessment of organelle structure/function relationships is limited to the cell wall and cell membrane. Assessment of the function of the other organelles is limited to their relationship to the whole cell. Assessment does not include the biochemical function of cells or cell parts.]
- 6-LS1-3 Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells.** [Clarification Statement: Emphasis is on the conceptual understanding that cells form tissues and tissues form organs specialized for particular body functions. Examples could include the interaction of subsystems within a system and the normal functioning of those systems.] [Assessment Boundary: Assessment is limited to circulatory, excretory, digestive, respiratory, muscular, and nervous systems. Assessment does not include the mechanism of one body system independent of others.]
- 6-LS1-8 Gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories.** [Assessment Boundary: Assessment does not include mechanisms for the transmission of this information.]

The performance expectations above were rearranged using the Arkansas K-12 Science Standards for Grades 6-8.

Topic 2: Matter and Energy in Organisms

Students who demonstrate understanding can:

- 7-PS1-1 Develop models to describe the atomic composition of simple molecules and extended structures.** [Clarification Statement: Emphasis is on developing models of molecules that vary in complexity. Examples of simple molecules could include ammonia and methanol. Examples of extended structures could include sodium chloride or diamonds. Examples of molecular-level models could include drawings, 3-D ball and stick structures, or computer representations showing different molecules with different types of atoms.] [Assessment Boundary: Assessment does not include valence electrons and bonding energy, discussing the ionic nature of subunits of complex structures, or a complete depiction of all individual atoms in a complex molecule or extended structure.]
- 7-PS1-2 Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.** [AR Clarification Statement: Examples of reactions could include burning sugar or steel wool, fat reacting with sodium hydroxide, and mixing zinc with hydrochloric acid.]

[Assessment Boundary: Assessment is limited to analysis of the following properties: density, melting point, boiling point, solubility, flammability, and odor.]

- 7-PS1-5** Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved. [Clarification Statement: Emphasis is on law of conservation of matter and on physical models or drawings, including digital forms that represent atoms.] [Assessment Boundary: Assessment does not include the use of atomic masses, balancing symbolic equations, or intermolecular forces.]
- 7-PS1-6** Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes.* [AR Clarification Statement: Emphasis is on the design, controlling the transfer of energy to the environment, and modification of a device using factors such as type and concentration of a substance. Examples of designs could involve chemical processes such as dissolving ammonium chloride or calcium chloride or chemical reactions such as burning.] [Assessment Boundary: Assessment is limited to the criteria of amount, time, and temperature of substance in testing the device.]
- 7-LS1-7** Develop a model to describe how food is rearranged through chemical reactions forming new molecules that support growth and/or release energy as this matter moves through an organism. [Clarification Statement: Emphasis is on describing that molecules are broken apart and put back together and that in this process, energy is released.] [Assessment Boundary: Assessment does not include details of the chemical reactions for photosynthesis or respiration.]

The performance expectations above were rearranged using the Arkansas K-12 Science Standards for Grades 6-8.

Topic 3: Growth and Development

Students who demonstrate understanding can:

- 6-LS1-5** Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms. [Clarification Statement: Examples of local environmental conditions could include availability of food, light, space, and water. Examples of genetic factors could include large breed cattle and species of grass affecting growth of organisms. Examples of evidence could include drought decreasing plant growth, fertilizer increasing plant growth, different varieties of plant seeds growing at different rates in different conditions, and fish growing larger in large ponds than they do in small ponds.] [Assessment Boundary: Assessment does not include genetic mechanisms, gene regulation, or biochemical processes.]
- 8-LS3-1** Develop and use a model to describe why structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism. [Clarification Statement: Emphasis is on conceptual understanding that changes in genetic material may result in making different proteins.] [Assessment Boundary: Assessment does not include specific changes at the molecular level, mechanisms for protein synthesis, or specific types of mutations.]
- 8-LS4-5** Gather and synthesize information about the technologies that have changed the way humans influence the inheritance of desired traits in organisms. [Clarification Statement: Emphasis is on synthesizing information from reliable sources about the influence of humans on genetic outcomes in artificial selection (such as genetic modification, animal husbandry, or gene therapy); or, on the impacts these technologies have on society as well as the technologies leading to these scientific discoveries.]
- 7-ETS1-3** Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success. [AR Clarification Statement: Examples could include analyzing data (GMO crops, gene therapy, and selective breeding) to determine the success of the technology used.]

The performance expectations above were rearranged using the Arkansas K-12 Science Standards for Grades 6-8.

Topic 4: Ecosystems

Students who demonstrate understanding can:

- 6-ESS3-4** Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems. [Clarification Statement: Examples of evidence include grade-appropriate databases on human populations or the rates of consumption of food and natural resources (such as freshwater, minerals, or energy). Examples of impacts could include changes to the appearance, composition, or structure of Earth's systems as well as the rates at which they change. The consequences of increases in human populations and consumption of natural resources are described by science, but science does not make the decisions for the actions society takes.]
- 7-LS2-1** Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem. [Clarification Statement: Emphasis is on cause and effect relationships between resources and growth of individual organisms and the numbers of organisms in ecosystems during periods of abundant and scarce resources.]
- 7-LS2-3** Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem. [Clarification Statement: Emphasis is on describing the conservation of matter and flow of energy into and out of various ecosystems, and on defining the boundaries of the system.] [Assessment Boundary: Assessment does not include the use of chemical reactions to describe the processes.]
- 7-LS2-4** Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations. [Clarification Statement: Emphasis is on recognizing patterns in data and making warranted inferences about changes in populations, and on evaluating empirical evidence supporting arguments about changes to ecosystems.]
- 7-ETS1-1** Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions. [AR Clarification Statement: Examples could include designing technologies (such as levees, dams, storm shelters) and determining their ability to mitigate the effects of future weather events. Students could investigate ways that humans consume resources and design a solution to a problem created by increased human population and consumption.]

The performance expectations above were rearranged using the Arkansas K-12 Science Standards for Grades 6-8.

Topic 5: Human Impact on Ecosystems

Students who demonstrate understanding can:

- 6-ESS3-3 Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.*** [Clarification Statement: Examples of the design process could include examining human environmental impacts, assessing the kinds of solutions that are feasible, and designing and evaluating solutions that could reduce that impact. Examples of human impacts could include water usage (such as the withdrawal of water from streams and aquifers or the construction of dams and levees), land usage (such as urban development, agriculture, or the removal of wetlands), and pollution (such as of the air, water, or land).]
- 7-LS2-2 Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.** [Clarification Statement: Emphasis is on predicting consistent patterns of interactions in different ecosystems in terms of the relationships among and between organisms and abiotic components of ecosystems. Examples of types of interactions could include competitive, predatory, and mutually beneficial.]
- 7-LS2-5 Evaluate competing design solutions for maintaining biodiversity and ecosystem services.*** [Clarification Statement: Examples of ecosystem services could include water purification, nutrient recycling, or prevention of soil erosion. Examples of design solution constraints could include scientific, economic, and social considerations.]
- 7-PS1-3 Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.** [Clarification Statement: Emphasis is on natural resources that undergo a chemical process to form a synthetic material. Examples of new materials could include new medicine, foods, and alternative fuels.] [Assessment Boundary: Assessment is limited to qualitative information.]
- 7-ETS1-1 Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.** [AR Clarification: Examples could include designing methods for monitoring human impacts and designing solutions to environmental challenges (water quality testing).]
- 7-ETS1-2 Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.** [AR Clarification: Examples could include evaluating a community's designs for protecting ecosystems or lack thereof.]
- 7-ETS1-4 Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.** [AR Clarification Statement: Examples could include exploring the sources of synthetic materials (plastics, toxins, and fertilizers) and their impacts on the society and the environment.]

The performance expectations above were rearranged using the Arkansas K-12 Science Standards for Grades 6-8.

Topic 6: Earth's Place in the Universe

Students who demonstrate understanding can:

- 8-PS2-4** **Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects.** [Clarification Statement: Examples of evidence for arguments could include charts displaying mass, strength of interaction, distance from the Sun, and orbital periods of objects within the solar system or data generated from simulations or digital tools.] [Assessment Boundary: Assessment does not include Newton's Law of Gravitation or Kepler's Laws.]
- 8-ESS1-1** **Develop and use a model of the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons.** [Clarification Statement: Examples of models can be physical, graphical, or conceptual.]
- 8-ESS1-2** **Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system.** [Clarification Statement: Emphasis for the model is on gravity as the force that holds together the solar system and Milky Way galaxy and controls orbital motions within them. Examples of models can be physical (such as the analogy of distance along a football field or computer visualizations of elliptical orbits) or conceptual (such as mathematical proportions relative to the size of familiar objects such as students' school or state).] [Assessment Boundary: Assessment does not include Kepler's Laws of orbital motion or the apparent retrograde motion of the planets as viewed from Earth.]
- 8-ESS1-3** **Analyze and interpret data to determine scale properties of objects in the solar system.** [Clarification Statement: Emphasis is on the analysis of data from Earth-based instruments, space-based telescopes, or spacecraft to determine similarities and differences among solar system objects. Examples of scale properties include the sizes of an object's layers (such as crust or atmosphere), surface features (such as volcanoes), or orbital radius. Examples of data include statistical information, drawings and photographs, or models.] [Assessment Boundary: Assessment does not include recalling facts about properties of the planets or other solar system bodies.]

The performance expectations above were rearranged using the Arkansas K-12 Science Standards for Grades 6-8.

Accelerated Physical Science

Topic 1: Elements, Matter, and Interaction

Students who demonstrate understanding can:

- PS-PS1-1** Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms. [AR Clarification Statement: This PE is partially addressed in this course. Examples of properties that could be predicted from patterns could include types of bonds (ionic & covalent) formed, numbers of bonds formed, and hydrogen bonds in water.] [Assessment Boundary: Assessment is limited to main group elements.]
- PS-PS1-2** Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties. [AR Clarification Statement: This PE is partially addressed in this course. Examples could include recognizing patterns to identify types of chemical reactions, such as, combustion, single replacement, double replacement, decomposition and synthesis.] [Assessment Boundary: Assessment does not include predicting chemical products.]
- PS-PS1-3** Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles. [AR Clarification Statement: This PE is partially addressed in this course. Emphasis is on understanding of the strengths of forces between particles including hydrogen bonding in water. Examples of particles could include ions, atoms, molecules, and networked materials (such as graphite). Examples of bulk properties of substances could include the melting point and boiling point, vapor pressure, and surface tension.] [AR Assessment Boundary: Assessment limited to materials of same states of matter.]
- PS-PS1-4** Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy. [Clarification Statement: Emphasis is on the idea that a chemical reaction is a system that affects the energy change. Examples of models could include molecular-level drawings and diagrams of reactions, graphs showing the relative energies of reactants and products, and representations showing energy is conserved.] [Assessment Boundary: Assessment does not include calculating the total bond energy changes during a chemical reaction from the bond energies of reactants and products.]
- PS-PS1-7** Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction. [AR Clarification Statement: This PE is partially addressed in this course. Emphasis is on demonstrating conservation of atoms through balancing chemical equations and assessing students' use of mathematical thinking, not on memorization and rote application of problem-solving techniques.] [Assessment Boundary: Assessment does not include the mole concept or complex chemical reactions.]

PS-ESS2-7 Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth. [AR Clarification Statement: This PE is partially addressed in this course. Emphasis in this course is on identifying and describing the evidence for simultaneous coevolution and the causes, effects, and feedbacks between the biosphere and Earth's other systems. Geoscience factors control the evolution of life, which in turn continuously alters Earth's surface. Examples include how photosynthetic life altered the atmosphere through the production of oxygen, which in turn increased weathering rates and allowed for the evolution of animal life; how microbial life on land increased the formation of soil which in turn allowed for the evolution of land plants; or how the evolution of corals created reefs that altered patterns of erosion and deposition along coastlines and provided habitats for the evolution of life forms.] [Assessment Boundary: Assessment does not include a comprehensive understanding of the mechanisms of how the biosphere interacts with all of Earth's other systems.]

The performance expectations above were rearranged using the Arkansas K-12 Science Standards for Grade 8 and Physical Science.

Topic 2: Forces and Motion

Students who demonstrate understanding can:

- 8-PS2-1 Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects.*** [Clarification Statement: Examples of practical problems could include the impact of collisions between two cars, between a car and stationary objects, and between a meteor and a space vehicle.] [Assessment Boundary: Assessment is limited to vertical or horizontal interactions in one dimension.]
- 8-PS2-2 Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.** [Clarification Statement: Emphasis is on balanced (Newton's First Law) and unbalanced forces in a system, qualitative comparisons of forces, mass and changes in motion (Newton's Second Law), frame of reference, and specification of units.] [Assessment Boundary: Assessment is limited to forces and changes in motion in one dimension in an inertial reference frame and to change in one variable at a time. Assessment does not include the use of trigonometry.]
- 8-PS3-1 Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object.** [AR Clarification Statement: Emphasis is on descriptive relationships between kinetic energy and mass separately from kinetic energy and speed. Examples could include riding a bicycle at different speeds, rolling different sized rocks downhill, or getting hit by a plastic ball versus a tennis ball.]

- 8-PS3-2** Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system. [Clarification Statement: Emphasis is on relative amounts of potential energy, not on calculations of potential energy. Examples of objects within systems interacting at varying distances could include changing the direction/orientation of a magnet, a balloon with static electrical charge being brought closer to a classmate's hair, and the Earth and either a roller coaster cart at varying positions on a hill or objects at varying heights on shelves. Examples of models could include representations, diagrams, pictures, or written descriptions of systems.] [Assessment Boundary: Assessment is limited to two objects and electric, magnetic, and gravitational interactions.]
- PS-PS2-1** Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration. [AR Clarification Statement: This PE is partially addressed in this course. Emphasis on qualitative analysis of data. Examples of data could include tables or graphs of position or velocity as a function of time for objects subject to a net unbalanced force, such as a falling object, an object rolling down a ramp, or a moving object being pulled by a constant force.] [AR Assessment Boundary: Assessment is limited to qualitative analysis of one-dimensional motion and to macroscopic objects moving at non-relativistic speeds.]
- PS-PS2-3** Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.* [Clarification Statement: Examples of evaluation and refinement could include determining the success of the device at protecting an object from damage and modifying the design to improve it. Examples of a device could include a football helmet or a parachute.] [Assessment Boundary: Assessment is limited to qualitative evaluations and/or algebraic manipulations.]
- PS-PS2-5** Plan and conduct an investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current. [Assessment Boundary: Assessment is limited to designing and conducting investigations with provided materials and tools.]
- PS-PS2-6** Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.* [Clarification Statement: Emphasis is on the attractive and repulsive forces that determine the functioning of the material. Examples could include why electrically conductive materials are often made of metal, flexible but durable materials are made up of long chained molecules, and pharmaceuticals are designed to interact with specific receptors.] [Assessment Boundary: Assessment is limited to provided molecular structures of specific designed materials.]
- PS-2-ETS1-1** Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants. [AR Clarification Statement: Examples of global challenges could be energy distribution, protective sports equipment, and transportation safety designs (automobile safety and shipping/packing materials).]

The performance expectations above were rearranged using the Arkansas K-12 Science Standards for Grade 8 and Physical Science.

Topic 3: Energy

Students who demonstrate understanding can:

- 8-PS2-3** Ask questions about data to determine the factors that affect the strength of electric and magnetic forces. [Clarification Statement: Examples of devices that use electric and magnetic forces could include electromagnets, electric motors, and generators. Examples of data could include the effect of the number of turns of wire on the strength of an electromagnet, or the effect of increasing the number or strength of magnets on the speed of an electric motor.] [Assessment Boundary: Assessment about questions that require quantitative answers is limited to proportional reasoning and algebraic thinking.]
- 8-PS2-5** Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact. [Clarification Statement: Examples of this phenomenon could include the interactions of magnets, electrically-charged strips of tape, and electrically-charged pith balls. Examples of investigations could include first-hand experiences or simulations.] [Assessment Boundary: Assessment is limited to electric and magnetic fields, and is limited to qualitative evidence for the existence of fields.]
- PS-PS3-1** Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known. [AR Clarification Statement: This PE is partially addressed in this course. Emphasis is on explaining the meaning of mathematical expressions used in the model.] [AR Assessment Boundary: Assessment is limited to basic algebraic expressions or computations.]

- PS-PS3-2** Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative position of particles (objects). [Clarification Statement: Examples of phenomena at the macroscopic scale could include the conversion of kinetic energy to thermal energy, the energy stored due to position of an object above the earth, and the energy stored between two electrically-charged plates. Examples of models could include diagrams, drawings, descriptions, and computer simulations.] [AR Assessment Boundary: Assessment is limited to mechanical energy.]
- PS-PS3-3** Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.* [Clarification Statement: Emphasis is on both qualitative and quantitative evaluations of devices. Examples of devices could include Rube Goldberg devices, wind turbines, solar cells, solar ovens, and generators. Examples of constraints could include use of renewable energy forms and efficiency.] [Assessment Boundary: Assessment for quantitative evaluations is limited to total output for a given input. Assessment is limited to devices constructed with materials provided to students.]
- PS-PS3-4** Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics). [Clarification Statement: Emphasis is on analyzing data from student investigations and using mathematical thinking to describe the energy changes both quantitatively and conceptually. Examples of investigations could include mixing liquids at different initial temperatures or adding objects at different temperatures to water.] [Assessment Boundary: Assessment is limited to investigations based on materials and tools provided to students.]
- PS-3-ETS1-3**
Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts. [AR Clarification Statement: Examples could include building and evaluating wind turbines, solar cells, solar ovens, and generators.]

The performance expectations above were rearranged using the Arkansas K-12 Science Standards for Grade 8 and Physical Science.

Topic 4: Waves

Students who demonstrate understanding can:

- 8-PS4-1** Use mathematical representations to describe a simple model for waves that includes how the amplitude of a wave is related to the energy in a wave. [Clarification Statement: Emphasis is on describing waves applying both qualitative and quantitative thinking.] [Assessment Boundary: Assessment does not include electromagnetic waves and is limited to standard repeating waves.]
- 8-PS4-2** Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials. [Clarification Statement: Emphasis is on both light and mechanical waves. Examples of models could include drawings, simulations, and written descriptions.] [Assessment Boundary: Assessment is limited to qualitative applications pertaining to light and mechanical waves.]
- 8-PS4-3** Integrate qualitative scientific and technical information to support the claim that digitized signals are a more reliable way to encode and transmit information than analog signals. [Clarification Statement: Emphasis is on the basic understanding that waves can be used for communication purposes. Examples could include using fiber optic cable to transmit light pulses, radio wave pulses in Wi-Fi devices, and conversion of stored binary patterns to make sound or text on a computer screen.] [Assessment Boundary: Assessment does not include binary counting. Assessment does not include the specific mechanism of any given device.]

- PS-PS4-1** Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media. [AR Clarification Statement: This PE is partially addressed in this course. Examples of data could include seismic waves and sound waves traveling through air and water.] [AR Assessment Boundary: Assessment is limited to describing relationships qualitatively.]
- PS-PS4-2** Evaluate questions about the advantages of using a digital transmission and storage of information. [Clarification Statement: Examples of advantages could include that digital information is stable because it can be stored reliably in computer memory, transferred easily, and copied and shared rapidly. Disadvantages could include issues of easy deletion, security, and theft.]
- PS-4-ETS1-2** Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. [AR Clarification Statement: Examples of possible problems could be cell phone reception, emergency radio transmission, and earthquake notification.]

The performance expectations above were rearranged using the Arkansas K-12 Science Standards for Grade 8 and Physical Science.

Topic 5: Interactions of Humans and the Environment

Students who demonstrate understanding can:

- PS-LS2-7** Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.* [AR Clarification Statement: This PE is partially addressed in this course. Examples of human activities could include urbanization, fracking, greenhouse gases and dams. [AR Assessment Boundary: Assessment is to include student choice from multiple scenarios.]
- PS-LS4-5** Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species. [AR Clarification Statement: This PE is partially addressed in this course. Emphasis is on physical changes to the environment (temperature change and acidification).]
- PS-ESS2-1** Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features. [AR Clarification Statement: Emphasis is on how the appearance of land features (mountains, valleys, and plateaus) and sea floor features (trenches, ridges, and seamounts) are a result of both constructive forces (volcanism, tectonic uplift, and orogeny) and destructive mechanisms (weathering, mass wasting, and coastal erosion).]

- PS-ESS3-1 Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.** [AR Clarification Statement: This PE is partially addressed in this course. Emphasis in this course is on key natural resources. Examples could include access to fresh water (rivers, lakes, and groundwater), regions of fertile soils (river deltas) and high concentrations of minerals and fossil fuels. Examples of natural hazards could be from interior processes (volcanic eruptions), surface processes (tsunamis, mass wasting, and soil erosion), and severe weather (hurricanes, floods, and droughts). Examples of the results of changes in climate that could affect populations or drive mass migrations include changes to sea level and regional patterns of temperature and precipitation.]
- PS-ESS3-2 Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.*** [AR Clarification Statement: This PE is partially addressed in this course. Emphasis in this course is on identifying possible problems to be solved (conservation, recycling, and on minimizing impacts).]
- PS-5-ETS1-1 Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.** [AR Clarification Statement: Examples could include research and analysis of the spread of zebra mussels, decline of chestnut trees, and the impact of fracking.]
- PS-5-ETS1-2 Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.** [AR Clarification Statement: Examples of design challenges could include solving man-made erosion problems, reducing thermal/light pollution, and safe disposal of fracking waste fluids.]
- PS-5-ETS1-3 Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.** [AR Clarification Statement: Examples could be the environmental effects of certain plastics (cost, safety, biodegradability, and recyclability) and evaluating the tradeoffs for each source of energy production.]
- PS-5-ETS1-4 Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.** [AR Clarification Statement: Examples of possible computer simulation resources could include PhET, ArcGIS, and InTeGrate-SERC.]

The performance expectations above were rearranged using the Arkansas K-12 Science Standards for Grades 6-8.

Accelerated Biology

Topic 1: Cycling of Matter and Energy

- B-LS1-5 Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.** [Clarification Statement: Emphasis is on illustrating inputs and outputs of matter and the transfer and transformation of energy in photosynthesis by plants and other photosynthesizing organisms. Examples of models could include diagrams, chemical equations, and conceptual models.] [Assessment Boundary: Assessment does not include specific biochemical steps.]
- B-LS1-7 Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed resulting in a net transfer of energy.** [Clarification Statement: Emphasis is on the conceptual understanding of the inputs and outputs of the process of cellular respiration.] [Assessment Boundary: Assessment should not include identification of the steps or specific processes involved in cellular respiration.]

B-LS2-3	Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions. [AR Clarification Statement: Emphasis is on conceptual understanding of the role of aerobic and anaerobic respiration in different environments. Explanation should include glycolysis and the processes within the mitochondria.]
B-LS2-4	Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem. [Clarification Statement: Emphasis is on using a mathematical model of stored energy in biomass to describe the transfer of energy from one trophic level to another and that matter and energy are conserved as matter cycles and energy flows through ecosystems. Emphasis is on atoms and molecules such as carbon, oxygen, hydrogen and nitrogen being conserved as they move through an ecosystem.] [Assessment Boundary: Assessment is limited to proportional reasoning to describe the cycling of matter and flow of energy.]
B-LS2-5	Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere. [Clarification Statement: Examples of models could include simulations and mathematical models.] [Assessment Boundary: Assessment does not include the specific chemical steps of photosynthesis and respiration.]
B-ESS2-6	Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere. [Clarification Statement: Emphasis is on modeling biogeochemical cycles that include the cycling of carbon through the ocean, atmosphere, soil, and biosphere (including humans), providing the foundation for living organisms.]

The performance expectations above were rearranged using the Arkansas K-12 Science Standards for Biology.

Topic 2: Structure and Function

Students who demonstrate understanding can:

- | | |
|----------------|---|
| B-LS1-1 | Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells. [AR Clarification Statement: A model of the process of protein synthesis may be needed to support the explanation of the formation of proteins including enzymes.] [Assessment Boundary: Assessment does not include identification of specific cell or tissue types, whole body systems, specific protein structures and functions, or the biochemistry of protein synthesis.] |
| B-LS1-2 | Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms. [AR Clarification Statement: Emphasis is on functions at the organism system level such as nutrient uptake, water delivery, and organism movement in response to neural |

stimuli. This could include all types of multicellular organisms. An example of an interacting system could be an artery depending on the proper function of elastic tissue and smooth muscle to regulate and deliver the proper amount of blood within the circulatory system]. [Assessment Boundary: Assessment does not include interactions and functions at the molecular or chemical reaction level.]

B-LS1-3 **Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.** [AR Clarification Statement: Examples of investigations could include heart rate response to exercise, stomate response to moisture and temperature, and root development in response to water levels.]

B-LS1-3ARa.
Develop and use a model to explain a negative feedback loop. [AR Clarification Statement: Examples of negative feedback loops could include regulation of blood sugar, blood pressure, body temperature, and transpiration in plants.]

B-LS1-3ARb.
Develop and use a model to demonstrate the mechanism of cell signaling as a basis of control for cell activities. [AR Clarification Statement: Examples of cell signaling mechanisms could include hormones, neurotransmitters, antigen/antibody interactions. Dysfunction within cell signaling mechanisms can lead to a disorders such as cancer or diabetes.]

B-LS1-6 **Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules.** [AR Clarification Statement: Emphasis is on using evidence from models and simulations to support explanations for the formation of polymers from monomers including carbohydrates, lipids, nucleic acids and proteins (enzymes).]

B-LS1-8AR **Plan and conduct an investigation to determine the relationship between the structure of a plasma membrane and its function.** [AR Clarification Statement: Focus is on transport mechanisms, such as diffusion, osmosis, endocytosis, exocytosis, phagocytosis and pinocytosis.]

The performance expectations above were rearranged using the Arkansas K-12 Science Standards for Biology.

Topic 3: Biodiversity and Population Dynamics

Students who demonstrate understanding can:

B-LS2-1 **Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.** [Clarification Statement: Emphasis is on quantitative analysis and comparison of the relationships among interdependent factors including boundaries, resources, climate, and competition. Examples of mathematical comparisons could include graphs, charts, histograms, and population changes gathered from simulations or historical data sets.] [Assessment Boundary: Assessment does not include deriving mathematical equations to make comparisons.]

B-LS2-2	Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales. [Clarification Statement: Examples of mathematical representations include finding the average, determining trends, and using graphical comparisons of multiple sets of data.] [Assessment Boundary: Assessment is limited to provided data.]
B-LS2-6	Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem. [AR Clarification Statement: Examples of changes in ecosystem conditions could result from modest biological or physical changes, such as moderate hunting or a seasonal flood or community interactions such as symbiotic relationships. Examples of extreme changes could include events such as volcanic eruption or sea level rise.]
B-LS2-7	Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.* [AR Clarification Statement: This PE is fully addressed in this course. Emphasis is on the impact of human activities on biodiversity such as dissemination of invasive species, habitat degradation, and water quality.] [AR Assessment Boundary: Assessment is to include student choice from multiple scenarios.]
B-LS2-8	Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce. [Clarification Statement: Emphasis is on: (1) distinguishing between group and individual behavior, (2) identifying evidence supporting the outcomes of group behavior, and (3) developing logical and reasonable arguments based on evidence. Examples of group behaviors could include flocking, schooling, herding, and cooperative behaviors such as hunting, migrating, and swarming.]
B-LS4-6	Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.* [AR Clarification Statement: Emphasis is on refining solutions for a proposed problem related to threatened or endangered species, genetic variation of organisms for multiple species, and biodiversity.]
B-3-ETS1-3	Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts. [AR Clarification Statement: Problems could include effect of logging on animal or human populations, response to invasive species, agricultural practices, creating dams, and maintaining fish populations in public lakes.]
B-3-ETS1-4	Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem. [AR Clarification Statement: Could include simulations of population dynamics, genetic drift, evolution, and migration.]
The performance expectations above were rearranged using the Arkansas K-12 Science Standards for Biology.	

Topic 4: Genetic Variations in Organisms

Students who demonstrate understanding can:

- B-LS1-4** **Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms.** [AR Clarification Statement: Emphasis on the role of mitosis within the cell cycle including the control mechanisms and the events occurring within interphase including DNA replication.]

- B-LS3-1** Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring. [AR Assessment Boundary: Assessment does include the phases of meiosis or the biochemical mechanism of specific steps in the process.]
- B-LS3-2** Make and defend a claim based on evidence that inheritable genetic variations may result from: (1) new genetic combinations through meiosis, (2) viable errors occurring during replication, and/or (3) mutations caused by environmental factors. [Clarification Statement: Emphasis is on using data to support arguments for the way variation occurs.] [Assessment Boundary: Assessment does not include the phases of meiosis or the biochemical mechanism of specific steps in the process.]
- B-LS3-3** Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population. [Clarification Statement: Emphasis is on the use of mathematics to describe the probability of traits as it relates to genetic and environmental factors in the expression of traits.]

The performance expectations above were rearranged using the Arkansas K-12 Science Standards for Biology.

Topic 5: Evolution by Natural Selection

- B-LS4-1** Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence. [AR Clarification Statement: Emphasis is on a conceptual understanding of the role each line of evidence has relating to common ancestry and biological evolution. Examples of evidence

could include similarities in DNA sequences, anatomical structures, and order of appearance of structures in embryological development. Sources for information may include cladograms and /or phylogenetic trees.]

B-LS4-2 Construct an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment.

[Clarification Statement: Emphasis is on using evidence to explain the influence each of the four factors has on number of organisms, behaviors, morphology, or physiology in terms of ability to compete for limited resources and subsequent survival of individuals and adaptation of species. Examples of evidence could include mathematical models such as simple distribution graphs and proportional reasoning.] [Assessment Boundary: Assessment does not include other mechanisms of evolution, such as genetic drift, gene flow through migration, and co-evolution.]

B-LS4-3 Apply concepts of statistics and probability to support explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait.

[Clarification Statement: Emphasis is on analyzing shifts in numerical distribution of traits and using these shifts as evidence to support explanations.] [Assessment Boundary: Assessment is limited to basic statistical and graphical analysis. Assessment does not include allele frequency calculations.]

B-LS4-4 Construct an explanation based on evidence for how natural selection leads to adaptation of populations.

[Clarification Statement: Emphasis is on using data to provide evidence for how specific biotic and abiotic differences in ecosystems (such as ranges of seasonal temperature, long-term climate change, acidity, light, geographic barriers, or evolution of other organisms) contribute to a change in gene frequency over time, leading to adaptation of populations.]

B-LS4-5 Evaluate the evidence supporting claims that changes in environmental conditions may result in:

(1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species. [AR Clarification Statement: Emphasis is on determining cause and effect relationships for how changes to the environment such as deforestation, overfishing, application of fertilizers, drought, flood, and the rate of change of the environment affect distribution or disappearance of traits in species.]

B-LS4-7AR Obtain, evaluate, and communicate the claim that eukaryotic cells evolved from prokaryotic cells.

[AR Clarification Statement: Evidence may include a comparison of the structure of prokaryotic and eukaryotic cells with an emphasis on compartmentalization and complexity as outlined in the theory of endosymbiosis.]

B-LS4-8AR Evaluate evidence to support the claim that viruses are subject to mutations and may have a positive, negative, or neutral impact on a species, including humans. [AR Clarification: Emphasis is on that viruses may contain DNA or RNA and require a host cell to replicate.]

B-ESS2-7 Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth. [AR Clarification Statement: This PE is fully addressed in this course. Emphasis in the course is on developing a claim and evaluating and critiquing the evidence for simultaneous co-evolution. Emphasis is on the causes, effects, and feedback loops between the biosphere and Earth's other systems which continuously alters Earth's surface. Examples could include how photosynthetic life altered the atmosphere through the production of oxygen, which increased weathering rates and allowed for the evolution of animal life; how microbial life on land increased the formation of soil which allowed for the evolution of land plants; and how the evolution of corals created reefs which altered patterns of erosion and deposition along coastlines and provided habitats for the evolution of life forms.] [Assessment Boundary: Assessment does not include a comprehensive understanding of the mechanisms of how the biosphere interacts with all of Earth's other systems.]

The performance expectations above were rearranged using the Arkansas K-12 Science Standards for Biology.

Topic 6: Life and Earth's Systems

Students who demonstrate understanding can:

- B-ESS2-2** Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems. [Clarification Statement: Examples could include climate feedbacks, such as how an increase in greenhouse gases causes a rise in global temperatures that melts glacial ice, which reduces the amount of sunlight reflected from Earth's surface, increasing surface temperatures and further reducing the amount of ice. Examples could also be taken from other system interactions, such as how the loss of ground vegetation causes an increase in water runoff and soil erosion; how dammed rivers increase groundwater recharge, decrease sediment transport, and increase coastal erosion; or how the loss of wetlands causes a decrease in local humidity that further reduces the wetland extent.]
- B-ESS2-4** Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate. [Clarification Statement: Examples of the causes of climate change differ by timescale, over 1-10 years: large volcanic eruption, ocean circulation; 10-100s of years: changes in human activity, ocean circulation, solar output; 10-100s of thousands of years: changes to Earth's orbit and the orientation of its axis; and 10-100s of millions of years: long-term changes in atmospheric composition.] [Assessment Boundary: Assessment of the results of changes in climate is limited to changes in surface temperatures, precipitation patterns, glacial ice volumes, sea levels, and biosphere distribution.]
- B-ESS2-5** Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes. [AR Clarification Statement: This PE is partially addressed in this course. Emphasis is on the properties of water including, heat capacity, density of water in its solid and liquid states, and polar nature of the water molecule and how these properties of water affect Earth materials for example: stream transportation and deposition, erosion, expansion of water as it freezes.]
- B-ESS3-5** Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems. [AR Clarification Statement: Examples of evidence (precipitation and temperature) for both data and climate models and their associated impacts (sea level changes, glacial ice volumes, and atmosphere and ocean composition) could be found at National Oceanic and Atmospheric Administration, National Weather Service, and United States Geological Survey.] [Assessment Boundary: Assessment is limited to one example of a climate change and its associated impacts.]
- B-6-ETS1-2** Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. [AR Clarification Statement: Proposed problems could include increases in pollution, greenhouse gases, water runoff and soil erosion, coastal erosion, and loss of wetlands.]
- B-6-ETS1-3** Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts. [AR Clarification Statement: The solutions could be designed by students or identified from scientific studies.]

The performance expectations above were rearranged using the Arkansas K-12 Science Standards for Biology.

Topic 7: Human Impacts on Earth's Systems

Students who demonstrate understanding can:

- B-ESS3-1 Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.** [AR Clarification Statement: This PE is fully addressed in this course. Emphasis is on the way climate change has impacted human populations and how natural resources and natural hazards impact human societies. Examples of climate change results which affect populations or drive mass migrations could include changes to sea level, regional patterns of temperature and precipitation, and types of crops and livestock available. Examples of the dependence of human populations on technology to acquire natural resources and to avoid natural hazards could include damming rivers, natural gas fracking, thunderstorm sirens, and severe weather text alerts.]
- B-ESS3-2 Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.*** [AR Clarification Statement: This PE is fully addressed in this course. Emphasis in this course is on the designs of possible solutions. Emphasis is on the conservation, recycling, and reuse of resources (minerals and metals), and on minimizing impacts. Examples could include developing best practices for agricultural soil use, mining (coal, tar sands, and oil shales), and pumping (petroleum and natural gas).]
- B-ESS3-3 Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.** [AR Clarification Statement: This PE is partially addressed in this course. Examples of factors that affect the management of natural resources include costs of resource extraction and waste management, per-capita consumption, and the development of new technologies. Examples of factors that affect human sustainability include agricultural efficiency, levels of conservation, and urban planning.] [Assessment Boundary: Assessment for computational simulations is limited to using provided multi-parameter programs or constructing simplified spreadsheet calculations.]
- B-ESS3-4 Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.*** [AR Clarification Statement: This PE is partially addressed in this course. Examples of data on the impacts of human activities could include the quantities and types of pollutants released, changes to biomass and species diversity, and changes in land surface (urban development, agriculture or livestock, and surface mining). Examples for limiting future impacts could range from local efforts (reducing, reusing, and recycling resources) to large-scale bioengineering design solutions (altering global temperatures by making large changes to the atmosphere or ocean).]
- B-ESS3-6 Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.** [AR Clarification Statement: Examples of Earth systems to be considered are the hydrosphere, atmosphere, cryosphere, geosphere, and biosphere. Examples of far-reaching impacts related to human activity, include how increases in one or more atmospheric gasses (CO_x, NO_x, SO_x, and volatile organic compounds), and particulate matter could impact other Earth systems. For example, an increase in carbon dioxide results in an increase in photosynthetic biomass and ocean acidification with resulting impacts on marine populations.] [Assessment Boundary: Assessment does not include running computational representations but is limited to using the published results of scientific computational models.]
- B-7-ETS1-1 Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.** [AR Clarification Statement: Examples could include recycling, increased atmospheric carbon dioxide, ocean acidification, impacts on marine populations, increased wildfire occurrence, deforestation, and overfishing.]
- B-7-ETS1-4 Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.** [AR Clarification Statement: Simulations could include management of natural resources for sustainable yields, agricultural efficiency to feed a growing world population, and urban planning to maximize green space.]

The performance expectations above were rearranged using the Arkansas K-12 Science Standards for Biology.

Topic 1: Matter and Chemical Reactions

- PCP-PS1-1** Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms. [AR Clarification Statement: This PE is fully addressed in this course. Examples of properties that could be predicted from patterns could include reactivity of metals, types of bonds formed, numbers of bonds formed, and reactions with oxygen.] [AR Assessment Boundary: Assessment is limited to main group elements. Assessment does not include exceptions to periodic trends.]
- PCP-PS1-2** Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties. [AR Clarification Statement: This PE is fully addressed in this course. Examples of chemical reactions could include the reaction of sodium and chlorine, carbon and oxygen, and carbon and hydrogen.] [Assessment Boundary: Assessment is limited to chemical reactions involving main group elements and combustion reactions.]
- PCP-PS1-3** Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles. [AR Clarification Statement: This PE is fully addressed in this course. Emphasis is on understanding the strengths of forces between particles, including identifying and naming specific intermolecular forces (dipole-dipole). Examples of particles could include ions, atoms, molecules, and networked materials (graphite). Examples of bulk properties of substances could include the melting point and boiling point, vapor pressure, and surface tension.] [Assessment Boundary: Assessment does not include Raoult's law calculations of vapor pressure.]
- PCP-PS1-6** Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium.* [Clarification Statement: Emphasis is on the application of Le Chatelier's Principle and on refining designs of chemical reaction systems, including descriptions of the connection between changes made at the macroscopic level and what happens at the molecular level. Examples of designs could include different ways to increase product formation including adding reactants or removing products.] [Assessment Boundary: Assessment is limited to specifying the change in only one variable at a time. Assessment does not include calculating equilibrium constants and concentrations.]
- PCP-PS1-7** Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction. [AR Clarification Statement: This PE is fully addressed in this course. Emphasis is on demonstrating conservation of mass through the mole concept and stoichiometry. Emphasis is on assessing students' use of mathematical thinking, not on memorization and rote application of problem-solving techniques.] [Assessment Boundary: Assessment does not include complex chemical reactions.]
- PCP-PS1-9AR** Construct and revise models representing coulombic interactions among molecular electron domains that produce stable molecular arrangements. [Clarification Statement: Emphasis is on constructing Lewis structures, identifying atomic hybridization (sp, sp², sp³), applying VSEPR theory to assign molecular geometry (examples: trigonal planar, trigonal pyramidal, tetrahedral), and determine molecular polarity in the context of adding/canceling bond dipoles.]
- PCP-1-ETS1-2** Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. . [AR Clarification Statement: Examples of real-world problems could include wastewater treatment, production of biofuels, and the impact of heavy metals or phosphate pollutants on the environment.]

The performance expectations above were rearranged using the Arkansas K-12 Science Standards for Principles of Chemistry and Physics.

Topic 2: Nuclear Reactions

Students who demonstrate understanding can:

- PCP-PS1-8** Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay. [Clarification Statement: Emphasis is on simple qualitative models, such as pictures or diagrams, and on the scale of energy released in nuclear processes relative to other kinds of transformations.] [Assessment Boundary: Assessment does not include quantitative calculation of energy released. Assessment is limited to alpha, beta, and gamma radioactive decays.]
- PCP-ESS1-1** Develop a model based on evidence to illustrate the life span of the sun and the role of nuclear fusion in the sun's core to release energy that eventually reaches Earth in the form of radiation. [Clarification Statement: Emphasis is on the energy transfer mechanisms that allow energy from nuclear fusion in the sun's core to reach Earth. Examples of evidence for the model include observations of the masses and lifetimes of other stars, as well as the ways that the sun's radiation varies due to sudden solar flares ("space weather"), the 11-year sunspot cycle, and non-cyclic variations over centuries.] [Assessment Boundary: Assessment does not include details of the atomic and sub-atomic processes involved with the sun's nuclear fusion.]
- PCP-ESS1-3** Communicate scientific ideas about the way stars, over their life cycle, produce elements. [Clarification Statement: Emphasis is on the way nucleosynthesis, and therefore the different elements created, varies as a function of the mass of a star and the stage of its lifetime.] [Assessment Boundary: Details of the many different nucleosynthesis pathways for stars of differing masses are not assessed.]
- PCP-ESS1-6** Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth's formation and early history. [Clarification Statement: Emphasis is on using available evidence within the solar system to reconstruct the early history of Earth, which formed along with the rest of the solar system 4.6 billion years ago. Examples of evidence include the absolute ages of ancient materials (obtained by radiometric dating of meteorites, moon rocks, and Earth's oldest minerals), the sizes and compositions of solar system objects, and the impact cratering record of planetary surfaces.]
- PCP-2-ETS1-1** Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants. [AR Clarification Statement: Emphasis is on the specific needs and constraints involved with power generation.]
- PCP-2-ETS1-2** Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. [AR Clarification Statement: Emphasis is on nuclear power management.]
- PCP-2-ETS1-3** Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts. [AR Clarification Statement: Emphasis is on the relationship between nuclear fission and fusion.]
- PCP-2-ETS1-4** Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem. [AR Clarification Statement: Examples could include nuclear weapons and nuclear medicine (radioisotopes or radiation therapy). Simulations can be found at PhET.]

The performance expectations above were rearranged using the Arkansas K-12 Science Standards for Principles of Chemistry and Physics.

Topic 3: Energy Flow

Students who demonstrate understanding can:

- PCP-PS1-4** Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy. [Clarification Statement: Emphasis is on the idea that a chemical reaction is a system that affects the energy change. Examples of models could include molecular-level drawings and diagrams of reactions, graphs showing the relative energies of reactants and products, and representations showing energy is conserved.] [Assessment Boundary: Assessment does not include calculating the total bond energy changes during a chemical reaction from the bond energies of reactants and products.]
- PCP-PS1-5** Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs. [Clarification Statement: Emphasis is on student reasoning that focuses on the number and energy of collisions between molecules.] [Assessment Boundary: Assessment is limited to simple reactions in which there are only two reactants; evidence from temperature, concentration, and rate data; and qualitative relationships between rate and temperature.]
- PCP-PS3-1** Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known. [AR Clarification Statement: This PE is fully addressed in this course. Emphasis is on explaining the meaning of mathematical expressions used in the model.] [AR Assessment Boundary: Assessment is limited to systems of two or three components and to thermal energy, kinetic energy, and the energies in gravitational, magnetic, or electric fields.]
- PCP-ESS1-2** Construct an explanation of the Big Bang theory based on astronomical evidence of light spectra, motion of distant galaxies, and composition of matter in the universe. [Clarification Statement: Emphasis is on the astronomical evidence of the red shift of light from galaxies as an indication that the universe is currently expanding, the cosmic microwave background as the remnant radiation from the Big Bang, and the observed composition of ordinary matter of the universe, primarily found in stars and interstellar gases (from the spectra of electromagnetic radiation from stars), which matches that predicted by the Big Bang theory (3/4 hydrogen and 1/4 helium).]
- PCP-ESS2-3** Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection. [Clarification Statement: Emphasis is on both a one dimensional model of Earth, with radial layers determined by density, and a three-dimensional model, which is controlled by mantle convection and the resulting plate tectonics. Examples of evidence include maps of Earth's three-dimensional structure obtained from seismic waves, records of the rate of change of Earth's magnetic field (as constraints on convection in the outer core), and identification of the composition of Earth's layers from high-pressure laboratory experiments.]
- PCP-ESS3-4** Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.* [AR Clarification Statement: This PE is fully addressed in this course. Emphasis is on the impacts of human activities on physical systems. Examples of data on the impacts of human activities could include the quantities and types of pollutants released (fertilizer, surface mining, and nuclear byproducts). Examples for limiting future impacts could range from local efforts (reducing, reusing, and recycling resources) to large-scale engineering design solutions (nuclear power, photovoltaic cells, wind power, and water power).]
- PCP-3-ETS1-1** Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants. [AR Clarification Statement: Examples of the applications could include renewable energy resources (solar cells and wind farms), the Haber process for the production of fertilizers, and increased fuel efficiency of combustion engines.]

The performance expectations above were rearranged using the Arkansas K-12 Science Standards for Principles of Chemistry and Physics.

Topic 4: Waves

Students who demonstrate understanding can:

- PCP-PS4-1 Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.** [AR Clarification Statement: This PE is fully addressed in this course. Examples of data could include electromagnetic radiation traveling in a vacuum and glass as well as seismic waves traveling through the Earth.] [Assessment Boundary: Assessment is limited to algebraic relationships and describing those relationships qualitatively.]
- PCP-PS4-3 Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than the other.** [Clarification Statement: Emphasis is on how the experimental evidence supports the claim and how a theory is generally modified in light of new evidence. Examples of a phenomenon could include resonance, interference, diffraction, and photoelectric effect.] [Assessment Boundary: Assessment does not include using quantum theory.]
- PCP-PS4-4 Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter.** [Clarification Statement: Emphasis is on the idea that photons associated with different frequencies of light have different energies, and the damage to living tissue from electromagnetic radiation depends on the energy of the radiation. Examples of published materials could include trade books, magazines, web resources, videos, and other passages that may reflect bias.] [Assessment Boundary: Assessment is limited to qualitative descriptions.]
- PCP-PS4-5 Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.*** [Clarification Statement: Examples could include solar cells capturing light and converting it to electricity; medical imaging; and communications technology.] [Assessment Boundary: Assessments are limited to qualitative information. Assessments do not include band theory.]
- PCP-4-ETS1-4**
Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem. [AR Clarification Statement: Examples could include information transfer using fiber optics, radio waves, and medical imaging.]

The performance expectations above were rearranged using the Arkansas K-12 Science Standards for Principles of Chemistry and Physics.

Topic 5: Forces

Students who demonstrate understanding can:

- PCP-PS2-1** Analyze data to support the claim that Newton’s second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration. [AR Clarification Statement: This PE is fully addressed in this course. Examples of data could include tables or graphs of position or velocity as a function of time for objects subject to a net unbalanced force (a falling object, an object rolling down a ramp, or a moving object being pulled by a constant force).] [Assessment Boundary: Assessment is limited to one-dimensional motion and to macroscopic objects moving at non-relativistic speeds.]
- PCP-PS2-2** Use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system. [Clarification Statement: Emphasis is on the quantitative conservation of momentum in interactions and the qualitative meaning of this principle.] [Assessment Boundary: Assessment is limited to systems of two macroscopic bodies moving in one dimension.]
- PCP-PS2-4** Use mathematical representations of Newton’s Law of Gravitation and Coulomb’s Law to describe and predict the gravitational and electrostatic forces between objects. [Clarification Statement: Emphasis is on both quantitative and conceptual descriptions of gravitational and electric fields.] [Assessment Boundary: Assessment is limited to systems with two objects.]
- PCP-PS3-5** Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction. [Clarification Statement: Examples of models could include drawings, diagrams, and texts, such as drawings of what happens when two charges of opposite polarity are near each other.] [Assessment Boundary: Assessment is limited to systems containing two objects.]
- PCP-ESS1-4** Use mathematical or computational representations to predict the motion of orbiting objects in the solar system. [Clarification Statement: Emphasis is on Newtonian gravitational laws governing orbital motions, which apply to human-made satellites as well as planets and moons.] [Assessment Boundary: Mathematical representations for the gravitational attraction of bodies and Kepler’s laws of orbital motions should not deal with more than two bodies, nor involve calculus.]
- PCP-ESS1-5** Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks. [AR Clarification Statement: Emphasis is on the ability of plate tectonics to explain the ages of crustal (continental and oceanic) rocks. Examples could include evidence of the ages of oceanic crust (lithosphere that includes crust and upper mantle and the asthenosphere) increasing with distance from mid-ocean ridges (a result of divergent boundaries/plate spreading) and the ages of North American continental crust increasing with distance away from a central ancient core (a result of past plate interactions).]
- PCP-5-ETS1-2**
Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. [AR Clarification Statement: Examples of solutions could include satellite deployment, airbag design, gravity assist, sports safety, and elevators.]

The performance expectations above were rearranged using the Arkansas K-12 Science Standards for Principles of Chemistry and Physics.

Topic 6: Systems

Students who demonstrate understanding can:

- PCP-ESS2-5 Plan and conduct an investigation of the properties of water and its effects on Earth materials and Surface processes.** [AR Clarification Statement: Emphasis is on mechanical and chemical investigations with water and a variety of solid materials to provide the evidence for connections between the hydrologic cycle and system interactions commonly known as the rock cycle. Examples of mechanical investigations include stream transportation and deposition using a stream table, erosion using variations in soil moisture content, or frost wedging by the expansion of water as it freezes. Examples of chemical investigations include chemical weathering and recrystallization (by testing the solubility of different materials) or melt generation (by examining how water lowers the melting temperature of most solids).]
- PCP-ESS3-3 Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.** [AR Clarification Statement: This PE is fully addressed in this course. Emphasis is on the cycle of natural resources (renewable and nonrenewable). Examples of natural resource management in Arkansas could include use of fertilizers and pesticides, energy production, and decline of mineral mining (bauxite and silver).] [Assessment Boundary: Assessment for computational simulations is limited to using provided multi-parameter programs or constructing simplified spreadsheet calculations.]
- PCP-6-ETS 1-3 Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.** [AR Clarification: An example could be to design a process to remove selected pollutants from a natural water source.]
- PCP-6-ETS 1-4 Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.** [AR Clarification Statement: Examples of simulations can be found and made at ArcGIS and in Global Positioning Systems.]

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Topic 7: Behavior of Gases

Students who demonstrate understanding can:

- PCP-PS1-10AR Use mathematical representations to support the kinetic molecular relationships between pressure, volume and temperature of a gas sample.** [AR Clarification: Emphasis is on qualitative predictions as well as calculations involving the ideal gas law given changes in pressure, volume, temperature, and mass of a gas sample.]
- PCP-7-ETS1-2 Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.** [AR Clarification: Solutions could be designed by student to engineer a simulated airbag with a weak acid and a strong base using the ideal gas law.]
- PCP-7-ETS1-4 Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.** [AR Clarification: Examples of possible computer simulations could include PhET.]

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